

On the Hauterivian-Barremian correlation between the South of the USSR and certain Southern and Northern regions of Europe

By

MIKHAEL V. KAKABADZE*)

With 2 tables

ABSTRACT

A biostratigraphical characteristic of the Hauterivian-Barremian of the South of the USSR is given and the Hauterivian-Barremian zonal correlation between the South of the

USSR, South-Eastern France, Northern Germany, England and the Volga region are discussed.

KURZFASSUNG

Die biostratigraphischen Besonderheiten der Hauterive-Barreme Abfolgen im Süden der USSR werden vorgestellt. Eine Zonen-Korrelation im Hauterive und Barreme zwischen

dem Süden der USSR, dem Wolgagebiet, Südost-Frankreich, Norddeutschland und England wird diskutiert.

INTRODUCTION

Zonal correlation of the Lower Cretaceous of the Mediterranean and North European areas is problematic and thus an investigation of the adjacent areas acquires especial significance.

Existence of Tethyan and Boreal ammonite species in the Lower Cretaceous of the Caucasus and Crimea indicates that they belong to the key areas for a successful solving of zonal correlation problems between the Tethyan and Boreal realms.

This problem was elucidated in many works, however some questions, including the Hauterivian-Barremian zonal subdivision and correlation, still are in need of perfection.

In this paper the question of the Hauterivian-Barremian biostratigraphical subdivision of the South of the USSR and its correlation with the synchronous deposits of the South-

Eastern France and some of Northern European regions (Northern Germany, England, Volga region) are discussed. The detailed historical review of the problem is given in our previous work (KAKABADZE, 1981). It must be noted that when characterising the Hauterivian-Barremian zones of the South of the USSR and their boundaries, besides the authors data, all the main publications were taken into account; among them the works of V. P. RENNIGARTEN, 1951; M. S. ERISTAVI, 1951, 1964, N. P. LUPPOV, 1952, 1956; V. V. DRUSHTCHITZ, 1960, 1962; V. V. DRUSHTCHITZ and I. A. MIKHAILOVA, 1966; V. V. DRUSHTCHITZ and T. N. GORBATCHIK, 1979; T. A. MORDVILKO, 1960, 1962; V. L. EGOIAN, 1968; V. L. EGOIAN and G. A. TKATSHUK, 1965; A. G. KHALILOV, 1959.

*) M. V. KAKABADZE, Geological Institute Akad. Sci. Georgian SSR, Z. Roukhadze str. 1, korp. 9, USSR, 380093 Tbilisi.

THE HAUTERIVIAN OF THE SOUTH OF THE USSR

The Hauterivian deposits are rich in ammonites in the Crimea and in the central and western part of the Caucasus, but to the East the ammonites become scarce and in the Transcaucasian regions they are very rare. Basing on the characteristic complexes of ammonite species the Hauterivian of the South of the USSR is subdivided into two substages with two zones in each of them.

1. The Zone of *Acanthodiscus radiatus*-*Endemoceras ambli-gonium*

The base of the Hauterivian is defined by the first appearance of genera *Acanthodiscus*, *Crioceratites*, *Saynella* and *Spitidiscus*. The typical Valanginian genera such as *Kilianella*, *Thurmanniceras*, *Saynoceras*, *Sarasinella*, *Polyptychites* and *Dichotomites* in Hauterivian of the South of the USSR are not known.

There are the following characteristic species in the *Acanthodiscus radiatus*-*Endemoceras ambli-gonium* Zone: *Acanthodiscus radiatus radiatus* BRUG., *A. radiatus baksanensis* RENNG., *A. radiatus praematurus* RENNG., *A. karakaschi* KIL., *Leopoldia leopoldiana* D'ORB., *L. bargamensis* KIL., *Endemoceras ambli-gonium* NEUM. et UHL., *E. castellanense* D'ORB., *E. castellanense caucasicum* EG., *E. biasalense* BL., *Oosterella cultrata* D'ORB. etc.

2. The Zone of *Crioceratites sablieri*

The base of this zone is defined by the appearance of *Crioceratitinae*: *C. sablieri* AST., *C. nolani nolani* KIL., *C. nolani biasalensis* LUPP., *C. duvali* LEV., *C. munieri* SAR. et SCHOND., *C. kiliani* SARK. On this level *Leopoldia leopoldiana* D'ORB., *L. biasalensis* KAR., *L. lorioli* BAUM., *Spitidiscus incertus* D'ORB., *Aegocrioceras seeleyi* NEUM. et UHL. and *Endemoceras oxygonium* NEUM. et UHL. are also met. This zone is better characterised faunistically in the central and western parts of the North Caucasus, comparatively poorly in the Crimea and in the Western Georgia, whereas in the other regions of the South of the USSR this zone is hard to define because of the absence of typical ammonites.

3. The Zone of *Speetonicerias inversum*-*Subsaynella sayni*

The base of this zone marks the base of Upper Hauterivian substage. It is characterised by the first appearance of *Simbirskites*, *Speetonicerias*, as well as *Subsaynella*. The following

most typical ammonite species of this zone are met in the North Caucasus and Crimea: *Speetonicerias inversum* M. PAVL., *S. subinversum* M. PAVL., *S. auerbachii* EICHW., *S. versicolor* TRAUTSCH., *S. speetonense* JOUNG. et BIRD. and *Simbirskites coronatiformis* PAVL. Among the typical Mediterranean representatives the *C. nolani nolani* KIL., *C. duvali* LEV., few specimens of *Montoniceras anulare* D'ORB., *M. honoratianum* D'ORB., as well as *Pseudothurmannia* (*Balearites*) *balearis* NOL. and *P. (B.) tauricus* EICHW. are found in these regions. Besides the two latter species of *Crioceratitinae* in Transcaucasian the following species are met: *Subsaynella sayni* PAQ., *S. sp.*, *Speetonicerias auerbachii* EICHW., *S. inversum* M. PAVL., *S. versicolor astarta* GLAS., *Biasaloceras sauclum* M. PAVL., *Crioceratites duvali* LEV. etc.

4. The Zone of *Pseudothurmannia mortilleti*-*Craspedodiscus discofalcatus*

For the both Upper Hauterivian zones (*Speetonicerias inversum*-*Subsaynella sayni* and *Pseudothurmannia mortilleti*-*Craspedodiscus discofalcatus*) many genera (or subgenera), such as *Speetonicerias*, *Simbirskites*, *Crioceratites*, *Pseudothurmannia* (*Balearites*) etc. are common, but the boundary between them is clearly drawn by the first appearance of *Pseudothurmannia* (*Pseudothurmannia*), *Craspedodiscus* and *Acrioceras* (*Hoplocrioceras*).

The following species complex is characteristic for the *Pseudothurmannia mortilleti*-*Craspedodiscus discofalcatus* Zone: *Pseudothurmannia* (*P.*) *mortilleti* PICT. et LOR., *P. (P.) picteti* SARK., *P. (P.) biassalensis* (DIMITR.), *P. (P.) renevieri* SAR. et SCHOND., *P. (P.) pseudomalbosi* SAR. et SCHOND., *P. (Balearites) balearis* NOL., *Craspedodiscus discofalcatus* LAH., *C. phillipsi* NEUM. et UHL., *C. caucasicus* RENNG., *Plesiospitidiscus ligatus* D'ORB., *Simbirskites decheni* LAH., *S. kowalewski* M. PAVL., *S. umbonatus* LAH., *Speetonicerias speetonense* JOUNG. et BIRD., *Spitidiscus ratula* SOW., *Acrioceras* (*Hoplocrioceras*) *pulcherrimum* D'ORB., *Crioceratites duvali* LEV., *C. honnoratii* LEV., *Biasaloceras sauclum* DRUZ. etc. As it was shown earlier (KAKABADZE, 1981) the species *P. (P.) angulicostata* D'ORB., mentioned in previous schemes as index-species for this zone, in the territory of the USSR is absent and hence, the species *P. (P.) mortilleti* PICT. et LOR. is chosen as index-species. This species is very common in the uppermost Hauterivian of the Caucasus and Crimea and it is characteristic of this level not only in the south of the USSR, but in many West European regions, including the "standart" uppermost Hauterivian in the France.

THE BARREMIAN OF THE SOUTH OF THE USSR

The Barremian in the territory under review is divided into two substages; in Lower Barremian only one *Holcodiscus caillaudi*-*Crioceratites emerici* Zone is defined, though in Western Georgia, as it will be shown, two zones are established. The Upper Barremian of the South of the USSR is divided into three zones: 1) *Hemihoplites soulieri*-?*Silesites seranonis*, 2) *Heteroceras astieri*-*Imerites favrei* (divides into two subzones - *Imerites giraudi* and *Colchidites securiformis*) and 3) *Turkmeniceras turkmenicum*-*Matheronites ridzewskyi*.

1. The Zone of *Holcodiscus caillaudi*-*Crioceratites emerici*

The base of *caillaudi* - *emerici* Zone marks the base of the Lower Barremian. The typical Hauterivian genera such as *Pseudothurmannia*, *Craspedodiscus*, *Simbirskites* and *Plesiospidiscus* are absent on this level and its base is defined by the first appearance of *Holcodiscus*, *Barremites* (s. str.), *Silesites*, *Paracrioceras*, *Pulchellia*, *Subpulchellia*, *Anabamulina*, *Hamulina*, *Auritina*, *Torcapella* etc. Among the transitive (from Hauterivian to Barremian) genera first of all the representatives of *Crioceratites*, *Acrioceras*, *Spitidiscus*, *Biasaloceras* and *Phyllopachyceras* must be mentioned. The following ammonite species complex is characteristic for this zone: *Holcodiscus caillaudi* D'ORB., *H. kiliani* PAQ., *H. perezi* D'ORB., *Spitidiscus andrussowi* KAR., *S. fallacior* COQ., *S. seunesi* KIL., *Hamulina subcylindrica* D'ORB., *Anabamulina picteti* EICHW., *Auritina aurita* EG., *Barremites vocantium* SAYN., *Crioceratites emerici* LEV., *C. tenuicostatus* THOM., *C. otobaasi* SARK., *C. thiollierei* (AST.), *Acrioceras* (*Acrioceras*) *mukleae* SARK., *A.* (*Hoplocrioceras*) *fissicostatum* (ROEM.), *A. (H.) dilatatum* D'ORB., *A. (H.) isocostatum* KAKAB., *Raspailites cassida* RASP., *Silesites vulpes* UHL., many representatives of *Pulchellidae* (see below) etc.

In Western Georgia above the *Holcodiscus caillaudi* Zone the second Lower Barremian Zone *Subpulchellia plana*-*Heinzia matura* is established (KOTETISHWILI, 1979). This zone besides the index-species is characterised by the following species: *Pulchellia galeata* BUCH., *P. multicostata* RIED., *P. aff. compressissima* D'ORB., *P. cf. riedeli* BUERGL., *Subpulchellia brevicostata* KOTET., *Crioceratites otobaasi* (SARK.), *Paracrioceras dolloi* (SARK.), *P. cf. elegans* (KOEN.) etc.

In the other regions of the South of the USSR only one Lower Barremian zone is identified and, therefore, till the appearance of the new additional data we leave only one zone (*Holcodiscus caillaudi*-*Crioceratites emerici*) in the Lower Barremian scheme of the south of the USSR.

2. The Zone of *Hemihoplites soulieri*-?*Silesites seranonis*

This zone is best represented in the Caucasus, in particular in Western Georgia. The base of this zone marks the base of the Upper Barremian, which is defined by the first appearance of *Hemihoplites*, *Audouliceras*, *Ancyloceras*, *Heteroceras*, *Procheloniceras* (*Eocheloniceras*). The typical genera (or sub-

genera) such as *Crioceratites*, *Acrioceras* (*Hoplocrioceras*) and *Spitidiscus* in Upper Barremian of the South of the USSR are not known. Among the transitive (from Lower to Upper Barremian) genera (or subgenera) *Paracrioceras*, *Acrioceras* (*Acrioceras*), *Barremites*, *Silesites*, *Holcodiscus*, *Hamulina*, *Macroscephites*, *Phyllopachyceras* and *Protetragonites* must be noted first of all.

The *Hemihoplites soulieri*-?*Silesites seranonis* Zone is characterised by the following ammonite species: *Hemihoplites* (*Hemihoplites*) *soulieri* (MATH.), *H. (H.) khwamliensis* (ROUCH.), *H. (H.) feraudianus* (D'ORB.), *Silesites seranonis* (D'ORB.), *Paracrioceras barremense* (KIL.), *P. denckmanni* (KOEN.), *P. stadlaenderi* (MULLER), *Audouliceras collignony* (SARK.), "*Acanthodiscus*" *amadei* (UHL.), *Barremites strettostoma* MATH., *Protetragonites crebrisulcatus* (UHL.), *Eulytoceras phestum* (MATH.), *E. thetys* D'ORB. etc.

3. The Zone of *Heteroceras astieri*-*Imerites favrei*

This zone is comparatively well represented in Western Georgia and Turkmenistan (Kopetdag, Tuarkir, Great and Minor Balkhans) and its base is defined by the first appearance of genera *Imerites*, *Eristavia*, *Argvethites* and *Colchidites*. These genera, together with the *Heteroceras*, *Barremites*, *Protetragonites* and *Phyllopachyceras*, are characteristic of this zone.

Heteroceras astieri-*Imerites favrei* Zone divides into two subzones: *Imerites giraudi* and *Colchidites securiformis*.

The *Imerites giraudi* Subzone is characterised by the following ammonite species complex: *Imerites giraudi giraudi* KIL., *I. giraudi multicostatus* TOVB., *I. giraudi angulicostata* TOVB., *I. favrei* ROUCH., *I. sparcicostatus* ROUCH., *Eristavia trishiensis* KAKAB., *E. dichotoma* (ERIST.), *Heteroceras astieri* D'ORB., *H. bifurcatum* D'ORB., *Argvethites varicostatus* KAKAB., *A. lashensis* ROUCH., *Colchidites kutatissiensis* KAKAB., *C. leenhardti* KIL., *Costidiscus recticostatus* D'ORB., *Hemihoplites* (*Hemihoplites*) *khwamliensis* ROUCH., *Protetragonites crebrisulcatus* UHL., "*Acanthodiscus*" *amadei* (UHL.) *Phyllopachyceras infundibulum* D'ORB. etc.

From this subzone the following species pass into the next *Colchidites securiformis* Subzone: *Heteroceras astieri* D'ORB., *Argvethites lashensis* ROUCH., *Imerites favrei* ROUCH., *I. sparcicostatus* ROUCH., *Eristavia dichotoma* (ERIST.), *Hemihoplites (H.) khwamliensis* ROUCH., *Protetragonites crebrisulcatus* UHL., "*Acanthodiscus*" *amadei* (UHL.), *Costidiscus recticostatus* D'ORB., *Phyllopachyceras infundibulum* D'ORB. etc.

The *Colchidites securiformis* Subzone, in its turn, is clearly distinguished by the first appearance of genera *Paraimerites*, *Pseudocrioceras* and by the abundance of the various species of the genera *Heteroceras*, *Argvethites* and *Colchidites*.

Besides the above mentioned transitive species, for the *Colchidites securiformis* Subzone namely the following species (or subspecies) are characteristic: *Colchidites securiformis* SIM., BAC. et SOR., *C. shaoriensis* DJAN., *C. ratsbensis* rats-

hensis ROUCH., *C. ratsbensis kopetdaghensis* TOVB., *C. sara-sini* ROUCH., *C. sp.*, *Heteroceras elegans* ROUCH., *H. vermiforme* ROUCH., *H. sp.*, *Argvethites minor* ROUCH., *A. balchanicus* KAKAB., *Paraimerites densecostatus* (RENNG.), *P. tsholashensis tsholashensis* (ROUCH.), *P. tsholashensis balchanicus* KAKAB., *P. sp.*, *Costidiscus microcostatus* SIM., BAC. et SOR., *Audouliceras tzotnei* (ROUCH.), *Eulytoceras rossi* PAR., *Euphylloceras thetys* D'ORB., *E. morelli* D'ORB., *Phyllo-pachyceras infundibulum* D'ORB., *Ph. baborensis* COQ., „*Acrioceras*“ *furcatum* D'ORB. etc.

4. The Zone of *Turkmeniceras turkmenicum*-*Matheronites ridzewskyi*

This uppermost Barremian zone is well characterised by the leading ammonite species in Turkmenistan (Kopetdag, Tuar-

kir, Great and Minor Balkhans) and in Daghestan. But, even in these regions the beds corresponding to this zone are comparatively poor in ammonites. The following species (or subspecies) are found in this zone: *Turkmeniceras turkmenicum turkmenicum* TOVB., *T. turkmenicum longicostata* TOVB., *T. geokderense* TOVB., *T. rarecostatum* BOGD., *T. tumidum* BOGD., *Hemihoplites (Matheronites) ridzewskyi* KAR., *H. (M.) trispinosus* (KOEN), *H. (M.) brevispinus* (KOEN.), *H. (Hemihoplites) turkmenicus* (LUPP.), *H. (H.) brevicostatus* (BOGD.), „*Acrioceras*“ *furcatum* D'ORB. This zone marks the top of the Upper Barremian of the South of the USSR (TOVBINA, 1963, BOGDANOVA, 1971, KAKABADZE, 1981) and the base of the next Lower Aptian deposits is defined by the first appearance of the typical representatives of the Deshayesitidae.

DISCUSSION OF CORRELATION

HAUTERIVIAN

The lowermost Hauterivian zone, named by W. KILIAN *Hoplites (Acanthodiscus) radiatus-Leopoldia castellanensis*, was subdivided by J. DEBELMAS and J.-P. THIEULOY (1965) into two zones: 1) *Lyticoceras* sp. (sp. 1) and 2) *Acanthodiscus radiatus*. But later, the beds with the *Lyticoceras* sp. (sp. 1) were proved to belong to the Uppermost Valanginian and hence the single *Acanthodiscus radiatus* Zone was defined and the appearance of *Acanthodiscus* was taken to mark the Valanginian/Hauterivian boundary (MOULLADE and THIEULOY, 1967, THIEULOY, 1973).

In the South of the USSR (North Caucasus, Crimea), as it was shown, the base of Hauterivian (i. e. the base of *Acanthodiscus radiatus-Endemoceras amblygonium* Zone) is also defined by the first appearance of *Acanthodiscus*, as well as of *Crioceratites*, *Saynella* and *Spitidiscus*. Containing some ty-

pical Tethyan species, this zone is close to the “standart” *radiatus* zone. The existence in both regions of the following species: *Acanthodiscus radiatus radiatus* BRUG., *Leopoldia leopoldiana* D'ORB., *L. castellanensis castellanensis* D'ORB., *L. bargamensis* KIL. and *Oosterella cultrata* D'ORB., is of great importance for their correlation.

On the other hand, it is very important that *Endemoceras amblygonium* NEUM. et UHL. occurs together with the above mentioned ammonite species of the lowermost Hauterivian Zone of the South of the USSR, being its second index-species. In the North-West Europe (Northern Germany, England) the *Endemoceras amblygonium* is also the index-species of the lowest Hauterivian Zone and, thus, the correlation of the mentioned levels (zones) of these two regions is quite possible.

The second *Crioceratites sablieri* Zone of the South of the USSR, as it was shown, is characterised by the abundance of

Stage	Sub-stage	South-East France		South of the USSR (this paper)	Volga region (DROSHITZITZ, 1966)	Northern Germany (KEMPER, 1976)	England (RAWSON et al., 1978)
		(KILIAN, 1910)	(THIEULOY, 1973)				
HAUTERIVIAN	UPPER	<i>Hop. (N.?) angulicostatus</i>	<i>P. angulicostata</i>	<i>P. mortilleti</i> - <i>Cr. discofalcatus</i>	<i>Cr. discofalcatus</i> - <i>Sp. decheni</i>	<i>S. (Cr.) discofalcatus</i>	<i>Cr. variabilis</i>
			<i>Pl. ligatus</i>				<i>S. (Cr.) gottschei</i>
	<i>D. sayni</i>	<i>Sub. sayni</i>	<i>Sp. inversum</i> - <i>Sub. sayni</i>	<i>Sp. speetonensis</i>	<i>S. (M.) staffi</i>	<i>M. speetonensis</i>	<i>S. (Sp.) inversum</i>
LOWER	<i>C. duvali</i>	<i>N. nodosoplicatus</i>	<i>C. sablieri</i>	-	<i>E. regale</i>	<i>E. regale</i>	
		<i>Ol. jeannoti</i>					
		<i>C. loryi</i>					<i>E. noricum</i>
<i>Hop. (A.) radiatus</i> <i>L. castellanensis</i>	<i>A. radiatus</i>	<i>A. radiatus</i> - <i>E. amblygonium</i>	-	<i>E. amblygonium</i>	<i>E. amblygonium</i>		

Table 1. Correlation of Hauterivian zonal schemes for the South of the USSR, South-East of France, Volga region, Northern Germany and England.

the Tethyan ammonite species (*Crioceratites duvali* LEV., *C. nolani nolani* KIL., *C. kiliani* SARK., *C. sablieri* AST., *Spitidiscus incertus* D'ORB. etc.) and it obviously corresponds to the zones: 1) *Crioceratites loryi*, 2) *Olcostephanus jeannoti* and 3) *Neocomites nodosoplicatus* in the "standart" scheme by J.-P. THIEULOUY (1973).

As to the correlation of *Crioceratites sablieri* Zone with the North-West European Lower Hauterivian synchronous deposits the data are still insufficient; in the *Crioceratites sablieri* Zone of the South of the USSR the typical Boreal species are absent and, hence, only by its stratigraphical position it can be assumed that the *Crioceratites sablieri* Zone corresponds to the *Endemoceras noricum* and *Endemoceras regale* Zones of north Germany (see scheme E. KEMPER, 1976) and England (see scheme P. RAWSON et al., 1978). In all these three regions the correlate interval is situated between the *Acanthodiscus radiatus* – *Endemoceras ambligonium* Zone of the South of the USSR or *Endemoceras ambligonium* Zone of North Germany and England and Upper Hauterivian *Speetonicerases inversum* – *Subsainella sayni* Zone of the South of the USSR or *Speetonicerases inversum* Zone of North Germany and England (table 1).

On the basis of the additional palaeontological and stratigraphical data the Upper Hauterivian of the south-eastern France was divided not into two (*S. sayni* and *P. angulicostata* by W. KILIAN, 1910) but into the three zones: 1) *Subsainella sayni*, 2) *Plesiospitidiscus ligatus* and 3) *Pseudothurmannia angulicostata* (MOULLADE, 1966, MOULLADE and THIEULOUY, 1967, THIEULOUY, 1973).

In the other west European Mediterranean regions (Spain, Majorca, Bulgaria, Romania etc.), as well as in the South of the USSR the similar subdivision of the Upper Hauterivian is not possible.

As to the zonal correlation with the "standart" region, we can assume the data of the previous authors that *Speetonicerases inversum* – *Subsainella sayni* Zone of the South of the USSR corresponds to the "standart" *Subsainella sayni* Zone. On the other hand we consider that the next uppermost Hauterivian *Pseudothurmannia mortilleti* – *Craspedodiscus discofalcatus* Zone of the South of the USSR corresponds to the two "standart" *Plesiospitidiscus ligatus* and *Pseudothurmannia angulicostata* Zones (KAKABADZE, 1981). It is remarkable, that the leading species (in the "standart" region), such as *Plesiospitidiscus ligatus* D'ORB. is noted by V. L. EGOIAN from the uppermost Hauterivian of the north-western Caucasus together with the *Pseudothurmannia "angulicostata"* D'ORB., *Craspedodiscus discofalcatus* LAH., *Simbirskites decheni* LAH., etc., but unfortunately the exact stratigraphical position of *P. ligatus* D'ORB. is not known.

As to zonal correlation of the Upper Hauterivian of the South of the USSR and some typical Boreal regions (North Germany, England, Volga region) first of all it must be noted that in the late Hauterivian the ammonite migration process, especially their progressing from north to south was rather intensified. The typical Boreal genera such as *Speetonicerases*, *Craspedodiscus* and *Simbirskites* were spread not only in the North Caucasus, but in the Transcaucasian regions as well. Thus, existence of the mixed ammonite fauna in the Upper Hauterivian of the South of the USSR (see above) allow to conclude the following: the lower *Speetonicerases inversum* –

Subsainella sayni Zone of the South of the USSR in all probability, corresponds to the two Upper Hauterivian *inversum* and *staffi* Zones of North Germany and to the *inversum* and *speetonensis* Zones of North-East England, as well as to the *Speetonicerases versicolor*–*S. subinversum* and *S. speetonensis* Zones of the Volga region.

The uppermost Hauterivian *Pseudothurmannia mortilleti*–*Craspedodiscus discofalcatus* Zone of the South of the USSR comprises both Tethyan (*Pseudothurmannia (Pseudothurmannia) mortilleti* PICT. et LOR., *P. (P.) pseudomalbosi* SAR. et SCHÖND., *P. (P.) renevieri* SAR. et SCHÖND., *Crioceratites duvali* LEV. etc.) and Boreal (*Craspedodiscus discofalcatus* LAH., *Simbirskites kowalewskyi* M. PAVL., *S. umbonatus* LAH., *S. decheni* LAH. etc.) forms (species). It is remarkable that *Craspedodiscus discofalcatus* in the North Germany also is the index-species of the uppermost Hauterivian zone, where it occurs together with *S. kowalewskyi* M. PAVL.

In the Volga region the uppermost Hauterivian *Craspedodiscus discofalcatus*–*Speetonicerases decheni* Zone also contains (besides the mentioned index-species) the following species: common with the uppermost Hauterivian zone of the Caucasus *S. umbonatus* LAH., *C. speetonense* JOUNG. et BIRD., *C. phillipsi* NEUM. et UHL. etc.

Taking into account the mentioned data the correlation of the *Pseudothurmannia mortilleti*–*Craspedodiscus discofalcatus* Zone of the South of the USSR with the *Craspedodiscus discofalcatus*–*Speetonicerases decheni* of the Volga region, as well as with the two *Simbirskites (Craspedodiscus) gottschei* and *S. (Cr.) discofalcatus* Zones of North Germany is quite permissible (see table 1). The latter two zones, for their part, as it was shown by H. IMMEL (1979), correlates with the three uppermost Hauterivian zones: *Cr. gottschei*, *S. marginatus* and *Cr. variabilis* of England. As to the *Cr. variabilis* Zone of England, it (and the upper part of the German *Cr. discofalcatus* Zone) is suggested to be the lowest Barremian by E. KEMPER et al. (1981). This suggestion was based only on the occurrence at Speeton of *Crioceratites (Paracriocerases) spathi* at the base of the *Simbirskites variabilis* Zone. The noted species is not known outside of England and, as it is noted by E. KEMPER et al. (1981), it really shows the great resemblance with the *C. thiollieri* (AST.). As it has been lately proved the latter species appears not from the lowest Barremian, but from the late Hauterivian (see THOMEL, 1964, IMMEL, 1978). Taking into account these data we consider that till additional (supplementary) new palaeontological and stratigraphical information will be obtained the *S. variabilis* Zone of England (as well as the *C. discofalcatus* Zone of North Germany) must be left in the Upper Hauterivian (table 1).

BARREMIAN

When comparing the lower Barremian ammonite complexes of the South of the USSR and South-East of France it becomes evident that both of them are characterised by the flourishing of the following genera: *Holcodiscus*, *Pulchellia*, *Barremites*, *Hamulina* etc. Besides, there appear some new species of the following transitive genera: *Spitidiscus*, *Crioceratites*, *Acriceras*, *Euphyloceras*.

Stage Sub-stage	South-East France		South of the USSR (this paper)	Northern Germany	
	(KILIAN, 1910)	(BUSNARDO, 1965)		(KOENEN, 1908)	(KEMPER, 1976)
	UPPER	Cost. recti- cufatus		L. puzosianum	T. turkmenicum- Math. ridzewskyi
UPPER	Het. astieri- M. yvoni	S. seranonis Het. astieri	Het. astieri - I. favrei Colch. securiformis I. giraudi	C. sparsicosta C. pingue A. innexum A. costellatum	"A." innexum - Sim. pingue
LOWER	C. emerici - Pulch. comp- ressissima	N. pulchella Pulch. comp- ressissima Holc. kiliani	Hem. soulieri - S. seranonis Holc. caillaudi - C. emerici	C. denckmanni C. elegans C. fissicostatum C. rarocinctum C. strombecki	P. denckmanni P. elegans "H." fissicostatum "H." rarocinctum

Table 2. Correlation of Barremian zonal schemes for the South of the USSR, South-East France and Northern Germany.

Existence in both region of the same leading species such as *Holcodiscus gastaldi* D'ORB., *H. caillaudi* D'ORB., *Spitidiscus seunesi* KIL., *S. fallacior* COQ., *Crioceratites emerici* LEV., *Silesites vulpes* COQ., *Pulchellia cf. compressissima* D'ORB., *P. galeata* BUCH. etc. allow to conclude that *Holcodiscus caillaudi*-*Crioceratites emerici* Zone of the South of the USSR corresponds to the *Crioceratites emerici*-*Pulchellia compressissima* Zone of south-east France in scheme by W. KILIAN (1910) or to the both subzones of the *Niclesia pulchella* Zone (subzones: *Holcodiscus kiliani* and *Pulchellia compressissima*) in the scheme by R. BUSNARDO (1965) or to the *Emericiceras emerici* Zone in the scheme by M. MOULLADE (1966).

More complicated is the correlation of the Lower Barremian of Tethyan and Boreal regions. During the last 10 years this problem was rediscussed in many special papers (RAWSON, 1973, THIEULOY, 1973, IMMEL, 1979, KEMPER et al., 1981, KAKABADZE, 1981). It is remarkable that there is not a single same named Barremian zone in the areas under consideration and, hence, the detailed zonal correlation becomes extremely difficult. But, as it is presently proved (KAKABADZE, 1981), mainly by means of some representatives of *Crioceratitinae* the possibility exists of the mentioned zonal correlation. In the North-West Caucasus within the lower Barremian *Holcodiscus caillaudi* Zone ammonite complex the *Acrioceras* (*Hoplocrioceras*) *fissicostatum* (ROEM.) is mentioned by V. L. EGOIAN (1977) and in the upper part of the lower Barremian (namely in *Subpulchellia plana*-*Heinzia matura* Zone) of Georgia the *Paracrioceras cf. elegans* (KOEN.) was indicated (KAKABADZE, 1981). These species in the similar stratigraphical succession appear in the Barremian of north Germany; *A. (H.) fissicostatum* is the index-species of the third (from below) lower Barremian zone in the scheme by A. KOENEN (1908) or of the second zone in the scheme by E. KEMPER (1976). Unlike the A. KOENEN's scheme, E. KEMPER divides the Barremian not into two, but into three substages and the mentioned *fissicostatus* Zone crowns the Lower Barremian. The second noted species *Paracrioceras elegans* is also the index-species of the E. KOENEN's upper zone of the Lower Barremian or of the E. KEMPER's lowermost zone of

Middle Barremian. These data allow to propose that the Lower Barremian *Holcodiscus caillaudi*-*Crioceratites emerici* Zone of the South of the USSR corresponds to the *Crioceratites strombecki*, *Crioceratites rarocinctus*, *Crioceratites fissicostatus* and *Crioceratites elegans* Zones of A. KOENEN's (1908) scheme or "*Hoplocrioceras*" *fissicostatum* and *Paracrioceras elegans* Zones of E. KEMPER's (1976) scheme (table 2).

More complicated is the correlation problem of the Upper Barremian. As it is well known, in the "standart" Upper Barremian region there is only one *Silesites seranonis* Zone, with the three subzones (*Hemihoplites feraudi*, *Heteroceras astieri* and *Leptoceras puzosianum*) (BUSNARDO, 1965). As it was shown above, there is a more detailed Upper Barremian zonal scheme in the South of the USSR. The presence of *Paracrioceras barremense* KIL., *Hemihoplites* (*Hemihoplites*) *soulieri* (MATH.), *H. (H.) feraudianus* (D'ORB.), *Audouliceras collignoni* (SARK.) and *Barremites strettostonia* MATH. at the base of the Upper Barremian of these comparable regions allow to conclude that the "standart" *Hemihoplites feraudi* subzone corresponds to the *Hemihoplites soulieri*-*Silesites seranonis* Zone of the South of the USSR.

The second "standart" *Heteroceras astieri* Subzone correlates with the both subzones (*Imerites giraudi* and *Colchidites securiformis*) of the *Heteroceras astieri*-*Imerites favrei* Zone. As it was shown above, this level is characterised by the abundance of *Heteroceratidae*, among which the *Heteroceras astieri* D'ORB., *H. bifurcatum* D'ORB., *Imerites giraudi* KIL., *I. favrei* ROUCH., *Colchidites emerici emerici* D'ORB., *C. Leenhardti* KIL. and *C. kakbadzei* ROUCH. are met in both regions.

The uppermost *Turkmeniceras turkmenicum*-*Matheronites ridzewskyi* Zone is correlated with the "standart" *Leptoceras puzosianum* Subzone taking into account their stratigraphical position.

As to the Upper Barremian correlation of the South of the USSR and North Germany, first of all it must be noted that the migration process of ammonite species continued

mostly from the Boreal area southward and, hence, in the Upper Barremian of the South of the USSR there are some typical Boreal elements (mostly Ancyloceratids).

In the lowermost Upper Barremian zone of Western Georgia (*Hemiboplites soulieri-Paracrioceras barremense*) the two Boreal species – *Paracrioceras denkmanni* (MÜLLER) and *P. stadlaenderi* (MÜLLER) were found (KAKABADZE, 1981), and it is remarkable that in North Germany above the *Paracrioceras elegans* Zone namely *Paracrioceras denkmanni* Zone is established. On the same level the other mentioned species *P. stadlaenderi* (MÜLLER) was also found.

The second Upper Barremian *Heteroceras astieri-Imerites favrei* Zone of the South of the USSR does not contain the typical Boreal elements and, hence, it is still impossible to establish its correlative horizon by the ammonite fauna; in this case their stratigraphical position is of primary importance (see table 2).

In contrast to the *Heteroceras astieri-Imerites favrei* Zone, the uppermost Barremian *Turkmeniceras turkmenicum-Matheronites ridzewskyi* Zone of the South of the USSR contains

some Boreal ammonite species, namely: *Hemiboplites (Matheronites) brevispinus* (KOEN.) and *H. (M.) trispinosus* (KOEN.). As it is evident now, in North Germany they were collected from the *Crioceras rube* Zone by A. KOENEN (1908). Taking into account the mentioned palaeontological and stratigraphical data we can conditionally correlate *Turkmeniceras turkmenicum* – *Matheronites ridzewskyi* Zone of the South of the USSR with the two uppermost Barremian zones (*C. rube* und *C. aegoceras* – *C. bidentatum*) of North Germany (see table 2). In both regions immediately above these levels the first typical representatives of the Deshayesitidae appear, pointing out the beginning of the Lower Aptian Stage.

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